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(19) (CA) # CANADIAN PATENT

(54) FAIL SAFE FLUID POWERED ACTUATOR

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SUBSTITUTE

REMPLACEMENT

SECTION is not Present

Cette Section est Absente

This invention is directed to a fail-safe actuator system and in particular to a fail-safe brake actuator and a method of utilizing such actuators to provide sequential shutdown of cooperating system components.

In the operation of a large number of industrial systems, it is often imperative to have system braking provisions which are fail-safe, so that the occurrence of power failure or failure of a component does not lead to accident, loss of life, or undue damage to the related system. In the case of a conveyor system arranged in sequential feeding relation, the shutting down of system actuators, particularly on an emergency basis, presents a number of problems that are difficult to resolve. Thus, in the case of inter-connected conveyor belts a non-sequential shutdown of the belt drives probably leads to undesired over-feeding by belts that are still running, which deposit their loads upon non-moving belts of the system.

The present invention provides a hydraulic brake actuator system possessed of fail-safe characteristics, being thus able to shut down the associated component by actuating the component brake upon failure of either the electrical supply or the hydraulic system serving the component brake.

Thus, the present invention provides a fail-safe actuator comprising a pair of actuating modules in mechanical interconnection, the first module being a hydraulic actuator normally operable to exercise a desired function by the application of pre-determined fluid pressure thereto, the second module having resilient spring means capable of exerting a force against the first module at least as great as the actuating force output provided by the first module, and fluid actuated means holding the second module inoperative with the spring means in an energy storing

condition whereby on release of fluid pressure against the second module, the second module is activated. The rate of spring release and the consequent rate of activation of the first module is controlled by the rate of discharge of hydraulic fluid from the cylinder of the second module, under the action of the spring driven piston.

Making use of the disclosed fail-safe actuator, as for controlling the braking system of a complex conveyor belt system having a series of belts in respective feeding relation permits sequential shutdown of the system by adjusting the respective rates of operation of the individual actuators under failure conditions in order to provide desired rates and sequence of stopping of the respective conveyor system components. The system also functions for normal shutdown.

Certain embodiments of the present invention are described, references being made to the accompanying drawings wherein:

FIGURE 1 is a partial plan view of a caliper disc brake adapted to utilize the invention;

FIGURE 2 is a schematic arrangement of a complex conveyor system for which the subject fail-safe actuator is particularly suited; and

FIGURE 3 is a schematic circuit diagram and sectional view for an actuator according to the present invention.

Referring first to Figure 2, the conveyor system 10 comprises a conveyor 11 delivering to a second conveyor 12 which delivers in turn to a third conveyor 14. Each of the conveyors has a driving motor, only one of which is shown, together with a disc brake, each disc brake incorporating an actuator according to the present invention.

The brake arrangement, as illustrated in Figure 1

shows a shaft 24 having a disc 26 mounted thereon. A caliper brake arrangement 30 comprises a pair of tong arms 32 having an interconnecting brace 34 extending therebetween. At one end brake shoes 36 having brake pads 38 attached thereto are pinned to one end of the tong arms. At the other end of each arm are provided forked ends 40 between which extend the output portion of an actuator 50 as illustrated in Figure 3.

Referring to Figure 3, the actuator 50 is provided with a pair of output clevises 52, 54 for pinning to the brake calipers at the forked ends 40 shown in Figure 1. The actuator 50 comprises a hydraulic module portion 56 and the mechanical module portion 58. The first module 56 includes a cylinder 60 containing a piston 62 having a piston rod 64 connected thereto, which terminates at the caliper clevis 52. The cylinder 60 has second clevis 54 extending therefrom.

A second piston rod 66 extends rearwardly of the cylinder 60 into the cylinder 58. A piston 68 serves to compress a coil spring 70 within the cylinder 58.

A recess 73 receives the rearward end of the piston rod 66, providing a lost motion relationship therebetween to permit normal actuation of the first actuator module without effective interferance from the second or backup mechanical module. The recess is vented to drain to prevent hydraulic lock-up, by a vent passage 75 in the cylinder 58.

The actuator first module receives pressurized hydraulic fluid by way of lines 72, 74, while the second module receives pressurized hydraulic fluid by way of line 76. A drain line 77 prevents the occurrence of hydraulic lock.

The hydraulic system comprises an electric motor 80 driving a hydraulic pump 82 which receives oil by way of line 84 connected to the oil reservoir 85. The oil in the reservoir may be suitably cooled by a cooling coil 86 schematically illustrated. The "bil" serves as hydraulic fluid.

The hydraulic system is provided with a high pressure release valve 88 which exhausts by way of line 90 back to the reservoir 85.

The pump 82 delivers pressurized oil by way of line 92 to branch lines 94 and 96. Hydraulic line 94 connects with the cylinder 58 of the actuator second module, by way of line 76, while line 96 and associated return line 97 which connects with the oil reservoir 85 provides hydraulic fluid by way of connection 72, 74 to the cylinder 56 of the first module of the actuator.

The direction of admission of the pressurized hydraulic fluid to the actuator first module is controlled by a solenoid actuated off-on valve 100. A pressure reducing valve 102 limits the hydraulic pressure admitted to the control valve 100, in order to provide a desired rate of normal braking torque. Upstream of the reducing valve 102 there is a normally open pressure switch 104 connected with the conveyor drive motor, to interrupt the electrical supply to that motor in the event of failure of the hydraulic pressure in the braking system.

It will be understood that while a single actuator 50 is illustrated, in fact all three conveyors of the system may be energized by the same hydraulic pump 82.

In operation the brake system is normally continuously energized by the motor 80 driving the pump 82, thus providing pressurized hydraulic fluid to the solenoid valve 100, and to the line 76 of the second module 58 to hold

it immobilized. A check valve 110 in the line 76 maintains the second module in pressurized condition. A bypass drain line 116 connects the line 76 to drain. A pilot operated check valve 112 normally maintains the drain line 116 inoperative, being energized from line 115 to the closed condition. An adjustable throttle valve 114 controls the rate of emergency braking.

When the solenoid 100 is in the "off" position, the pump pressure is applied to the front chamber 61 of the first module 56, to hold the actuator arm clevises 52, 54 closed towards each other. Energization of the solenoid valve 100 to the "on" position by switch means (not shown) applies hydraulic pressure to the rear chamber 63 of the first module 56, spreading apart the clevises 52, 54 so as to press the brake pads 38 (see Figure 2) against the brake disc 26 in braking relation therewith. This constitutes normal application of the brakes. In the plural brake system disclosed, the respective pressure reducing valve 102 is set to a value of pressure relief to provide the desired rate of braking for the related brake set when the brakes are operated.

Upon the occurrence of system failure the energization of the motor 80 is interrupted, and each of the respective second modules 58 become depressurized, permitting the respective springs 70 to move the second piston rod 66 forward in brake actuating motion, to spread apart the clevises 52, 54 and thus apply the respective brake.

The lost motion space 73 which receives the second piston rod 66 contains some pressure fluid which leaks in from the line 76 past rod 66 during normal conditions. To prevent hydraulic lock, the space 73 is vented to drain, by way of passage 75 through the piston 68.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In a conveyor system having a plurality of conveyor belts arranged in sequential feeding relation, including a plurality of brake means, to control the operation of individual conveyors, having at least one driven pump to provide pressurized hydraulic fluid to the actuators of respective brake means, the improvement comprising emergency shut-down means connected to at least some of said conveyors, to apply individual mechanical actuation to said respection ones of said brake means, said shut-down means each including a hydraulic pressure cylinder to receive pressurized fluid from the pump, to hold an emergency actuation spring in compressed non-operative relation with the related said brake means, and adjustable throttle means to control the rate of discharge of fluid from said cylinder under the action of said spring to thereby permit actuation of the related said brake by said spring at a predetermined rate, upon failure of said pump means to maintain normal pressure in said pressure cylinders, whereby the respective rate of operation of said brakes on emergency shut down may be pre-selected to provide a predetermined sequence of shut-down of said conveyor belts, to minimize spillage thereover.

2. The system as claimed in claim 1 including lost motion connection means between a said brake means and the related said emergency shut-down means, to permit normal actuation of said brake means without effecting said emergency actuation spring, and providing mechanical cooperation of said brake means with said shut-down means in emergency.

3. The system as claimed in claim 1 or claim 2 wherein said brake means comprise disc brakes.

4. The system as claimed in claim 1 or claim 2 wherein said brake means comprise caliper disc brakes.

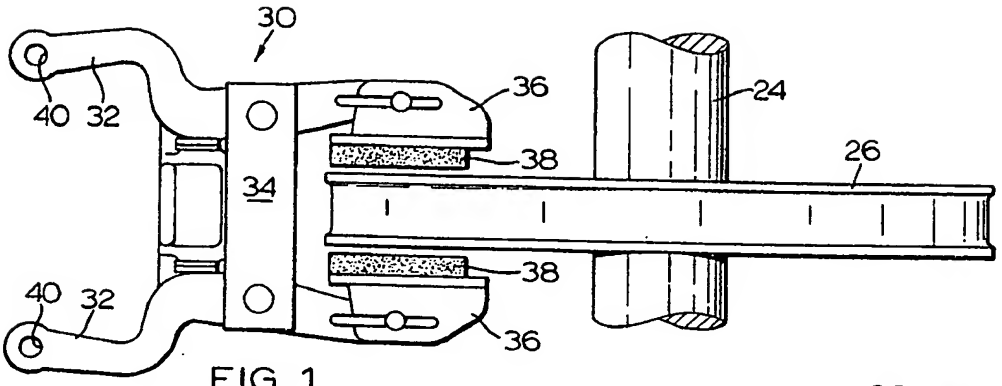

FIG. 1

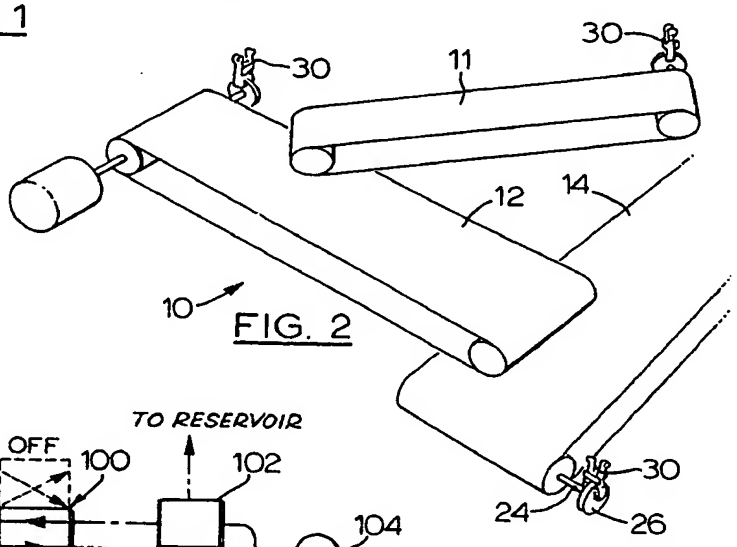

FIG. 2

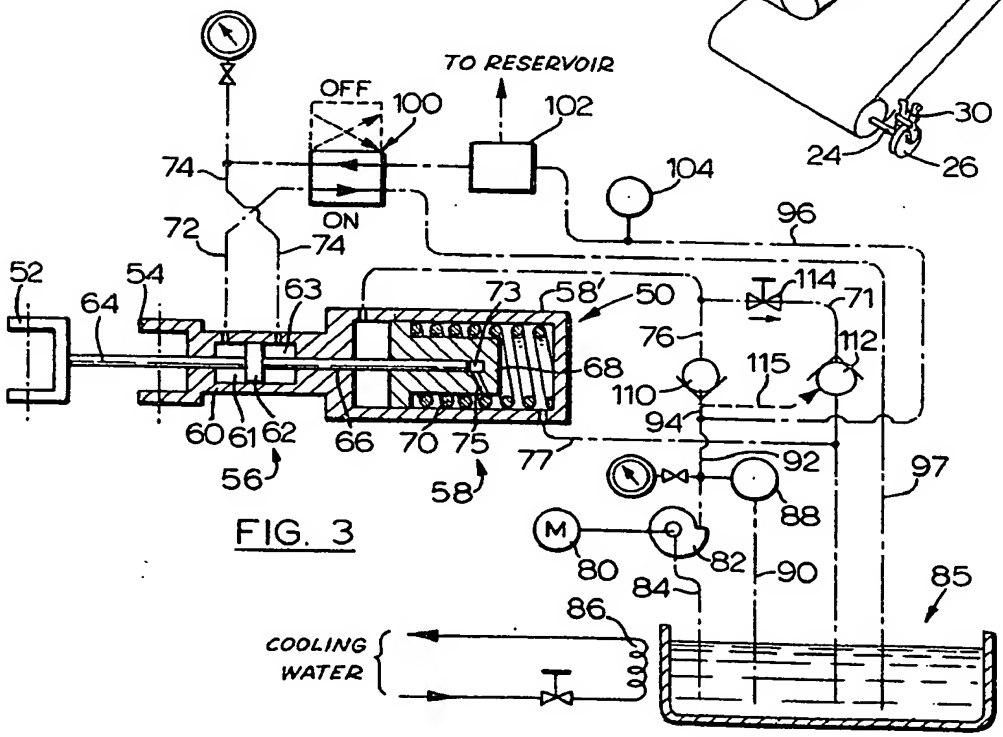

FIG. 3

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